Commissioning Plan
Reverse protons down AP-1 and AP-3

December 16, 1998

J. Morgan

1. Preparation

–The Main Injector, P-1 line and P-2 line must be capable of delivering 8-Gev beam to F-17.

–AP-1 line in the Tevatron enclosure must be restored to operating condition.

- Surveying of magnets upstream of PQ1 completed.
- Vacuum connections restored and line pumped down.
- LCW manifold on F-17 Lambertsons repaired, LCW flow restored to magnets.
- Power cables repaired and reconnected to magnets. Power supplies for 8-Gev operation working properly.
- Diagnostics have cables reconnected.

–Diagnostics in AP-1 and AP-3 must be in working order and timed correctly.

- SEM's
- BLM's
- Toroids and other miscellaneous devices.
- Beamline BPM's.
- Accumulator TBT.

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2. Establish reverse protons to the Accumulator

- –P2 line must be delivering beam to F17 centered in aperture and with a reasonable beam size and shape.
- –Center beam on SEM 100 to establish the proper beam trajectory up to the sewer pipe.
  - •Use trims in the P2 line to correct the beam position on SEM 100. Elements in the upstream end of AP-1 should only be used as a last resort.
  - •BLM's should be used to confirm beam is centered in the Lambertson aperture. Losses may be difficult to eliminate completely as 8-Gev beam fills much of the aperture.
- –Center beam on SEM 101 and SEM 103 to establish proper beam trajectory through the sewer pipe.
  - •P2 vertical trim is first choice, use M:F17DC only if necessary. M:HT100 is horizontal knob. Try not to use M:HV200 during this step, M:HT100 should be used first.
- –Center beam on SEM 105 and SEM 106 to establish proper beam trajectory approaching the AP-3 line.
  - •Use M:HV200 to adjust the horizontal position, be aware that it will have an affect in the vertical plane as well. Use M:HV202 only as a last resort. For vertical adjustments use M:F17DC first, and M:VT101 as a second choice.
  - •BLM's should again be used to confirm beam is centered in the beamline. Losses are normally low after the sewer pipe.

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–Check beam on SEM 926. Since the SEM 921 position is more important, make an adjustment only if there is an obvious loss problem.
- Use M:HV202 for horizontal adjustments, M:V205 for vertical adjustments.

–Center beam on SEM 921 to establish proper beam trajectory through the long transport section of AP-3. Be aware that SEM 921 and SEM 926 are a significant distance apart. The beam position on this SEM is particularly important so spend time to get it right.
- For Horizontal adjustments use D:H926, which is a dogleg around the target vault. M:V205 is the first choice for a vertical knob, D:VT925 is a less desirable alternative.

–Check the beam position on SEM917. There are no bending elements between SEM 921 and SEM 917, so any position error is either due to quad steering or (more likely) an angle introduced upstream. Normally SEM 917 will look OK if SEM 921 is centered.

–Check beam on SEM 913, this is located at the exit of the main string of horizontal bending magnets. As with SEM 917, this position is typically centered if SEM 917 and SEM 921 are.
- Plot D:TOR910 as a check of progress. If beam has been properly positioned to this point, transmission to this part of the line should be at least 80%. SEM's in the beam cause some of the lost efficiency. The F16 toroid should provide a measure of the beam intensity entering the AP-1 line. Efficiency is greatly affected by beam emittance entering the line. 5-10 beam can be transmitted very efficiently, larger beam will most likely get scraped.

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- –Center beam on SEM 909 and SEM 906.
  - Use D:H914 to adjust the horizontal position, use D:VT917 for vertical adjustments.
- –Center beam on SEM 900 to approximate correct steering into the Accumulator. Orbit closure should follow, closing the orbit is much more important than the position on SEM 900. Don't expect the positions on SEM 900 to be centered after tuning for maximum injection efficiency. Orbit closure is best done with an applications program, it is difficult and time consuming to do by hand.
  - Use D:HT906B, D:HT906A and D:HT901 to control horizontal beam trajectory at injection. Use D:VT906, D:VS904 and D:VS901 to control vertical beam trajectory.

AP-1/AP-3 efficiency should be greater than 80% (A:IBEAMV compared to M:F16TOR). When the AP-3 to Accumulator closure is properly done, there is very little beam loss between D:TOR910 and the Accumulator (A:IBEAMV). Document magnet settings and SEM Profiles after tuning is done.

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3. Define ideal positions

- –Do a second tuning iteration down AP-1/AP-3, exploring the aperture and centering the beam.
  - •Use local BLM's and SEM's to identify loss points, don't use D:TOR910 or Accumulator intensity as a guide at this point.
  - •Document magnet settings and SEM profiles with centered beam.
- –Minimize quadrupole steering in the beamlines.
  - •Adjust beam position through quadrupoles so as to minimize downstream position shifts as the quadrupole current is changed.
  - •PQ-1 (M:Q201) has the greatest likelihood of beam being off-center. Make sure that the extraction channel upstream of the sewer pipe was surveyed correctly when the beamline was shifted.
  - •Document magnet settings and SEM profiles with centered beam.
- –Reconcile ideal beam positions for beam centered in the aperture vs. beam centered in the quadrupoles.
  - •Attempt to make a compromise beamline tune that results in minimal quadrupole steering with good transmission.
  - •Document magnet settings and SEM profiles with centered beam. Change fiducials on the SEM applications pages to match. Also take BPM measurements for both lines, make protected save files and compare with SEM profiles.

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–After closing into the Accumulator, overall efficiency (assuming reasonable emittance entering the line) should be >95%. If the efficiency is lower, identify and fix loss points.

–Compare SEM profiles with expected beam widths from the beamline design. Consult with P2 expert if there are problems with the lattice or matching.